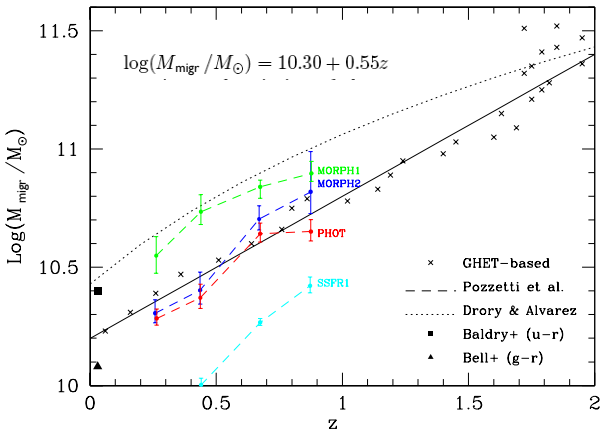

Fig. 5. Typical mass at which galaxies migrate on average to the passive sequence at a given z (crosses, see Figure 4). The solid line is a eye-fit to the crosses. The dashed lines correspond to the mass $M_{\rm cross}$ at which the late- and early-type $GSMF$s crosses, where different morphological, photometrical and SSFR criteria were used to separate the sample into late- and early-type galaxies (Pozzetti et al. 2010). See text for more details.

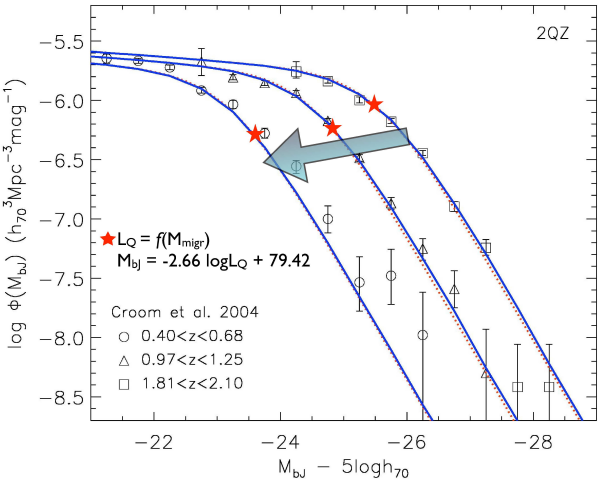

Fig. 6. The $M_{\rm migr}$ mass and its abundance translated to a quasar luminosity, L_Q, and abundance at three redshifts ($z = 0.5, 1$, and 2, filled stars). The obtained results are showed over the luminosity function plots of quasars at the three z bins indicated in the panel (Croom et al. 2004; Croton 2009; see text for details). The masses and abundances of galaxies in the migration process roughly coincide with the characteristic L_Q of the quasar luminosity functions at the same redshifts.

to determine the $GSMF$ at different epochs decomposed into early- (red) and late-type (blue) galaxies. For example, based on the zCOSMOS survey, Pozzetti et al. (2010) determined the mass at which the early- and late-type $GSMF$s cross (different estimators for these two populations are used) from $z \approx 1$ to $z \approx 0.2$. Such a crossing mass, $M_{\rm cross}$, is interpreted namely as the typical mass of late-type galaxies migrating to early-type ones (see also Bell et al. 2007). Local estimates of $M_{\rm cross}$ by Bell et al. (2003; filled triangle) and Baldry et al. (2004; filled square) are also plotted, as well as the law inferred by Drory & Alvarez (2008) for the mass above which the SFR as a function of $M_{\rm s}$ begins to drop exponentially, $M_{\rm quench}/M_\odot = 10^{10.43}(1+z)^{2.1}$. It is remarkable the agreement between direct estimates of different definitions of the characteristic mass above which the passive (red) population of galaxies dominates in number density (see also Bundy et al. 2006; Hopkins et al. 2007; Vergani et al. 2008) and the semi-empirical inferences of FA10.

Migration rates and the quasar connection.- Another prediction that can be made with the semi-empirical approach is the rate in comoving number density of galaxies migrating from active to passive ones as a function of z. In FA10 it was found that this rate, $\dot{\phi}_g(M_{\rm migr})$, up to $z = 1$ scatters around $(1.0 - 5.5) \times 10^{-4}$ gal/Gyr/Mpc^3 without any clear trend with z. These rates are in agreement with the estimated passive (red) population growth rate per unit of comoving volume determined by Pozzetti et al. (2010) for a redshift bin centered at $z = 0.34$.

If the typical time of galaxy transition (or quenching) is t_Q, then the abundance of galaxies per unit of comoving Mpc in the process of migration, i.e., those of mass $M_{\rm migr}$, is $\phi_{\rm g,migr} \approx \dot{\phi}_g(M_{\rm migr}) \times t_Q$. Let assume $t_Q = 100$ Myr and let estimate the typical luminosity of a bright quasar, $L_Q(z)$ associated to the stellar mass $M_{\rm migr}(z)$ or its corresponding halo mass $M_{\rm h}(z)$ (see e.g., Croton 2009) by making some assumptions ($L_Q = \eta L_{\rm Edd}$, $L_{\rm Edd} = C \times M_{\rm BH}$, $M_{\rm BH}$ is the supermassive black hole mass) and by using the observable correlations of $M_{\rm BH}$ with spheroid velocity dispersion or stellar mass. The result is very encouraging (Figure 6): at each z (up to $z \sim 3$), both $L_Q(M_{\rm migr})$ and its abundance, $\phi_{\rm g,migr}$, match the characteristic luminosity of the two-power law QSO luminosity function and its abundance as determined in Croon et al. (2004) and Robertson et al. (2006). This suggests that the transition from active to passive regime (quenching) in massive galaxies is associated to the QSO active phase.

3.2. *Implications*

In the semi-empirical approach described above, the observational input is the total $GSMF$ measured